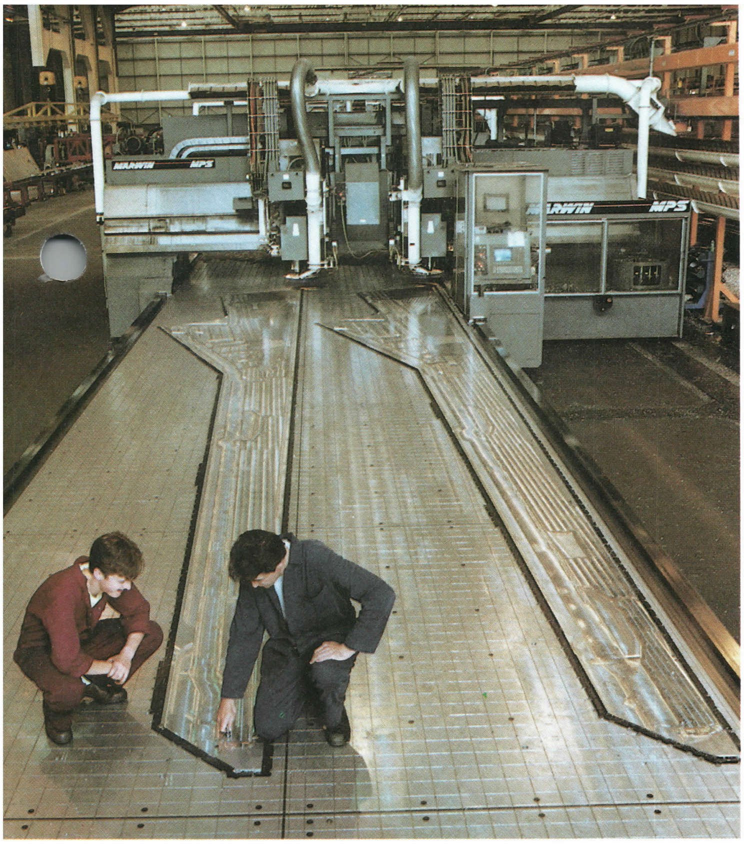


British Aerospace

The wings *for the largest aircraft built in Europe – the Airbus – are machined on the largest machine tool in Europe. The 530 tonne purpose-built machine is 66 metres long – the length of three cricket pitches – and 3.5 metres wide.*

makes the product itself. This process is known as CAM – computer aided manufacture.

But the use of computers in factory production lines can go much further than this. Computers can also be used to control the conveyor belts and unmanned vehicles that carry the components along the production line and the robot arms that fit the pieces together. Remote sensors can check cutting bits and the efficiency of each machine as well as running quality control checks on every item at every stage of the production line. All this data can be fed back to a central computer where the whole manufacturing process can be monitored.

In addition, business data can be fed into the system – sales figures and forecasts, production costs, profit margins and financial data – giving what is becoming known as CIM – computer integrated manufacture.

AEA Technology

Materials *in the nuclear industry normally need to be handled by remote control. The method shown here is known as adjacent handling.*

One example of this is a factory in Britain's Midlands, British United Shoe Machinery Co, that manufactures shoe-making machinery. Shoes all have the same basic components – leather, synthetic materials like rubber and metal for toe caps, heel guards and the eyes of lace holes. But there are an infinite number of different shoe designs. Some lines sell well, others badly. Different types sell better in winter than in the summer. Colours and styles change with fashion. Overall demand depends on the state of the economy, interest rates, wage settlements, and the rate of inflation; market trends and export orders are affected by currency fluctuations.

Forecasting trends

Using flexible manufacturing technology and computer integrated manufacturing, it is possible to produce any type of shoe in any number to fulfil any order. But business computer systems can also forecast forthcoming trends and when designers develop new designs, using CAD, these can be programmed into the system's library where they can be stored until the demand in the market is ready for them.

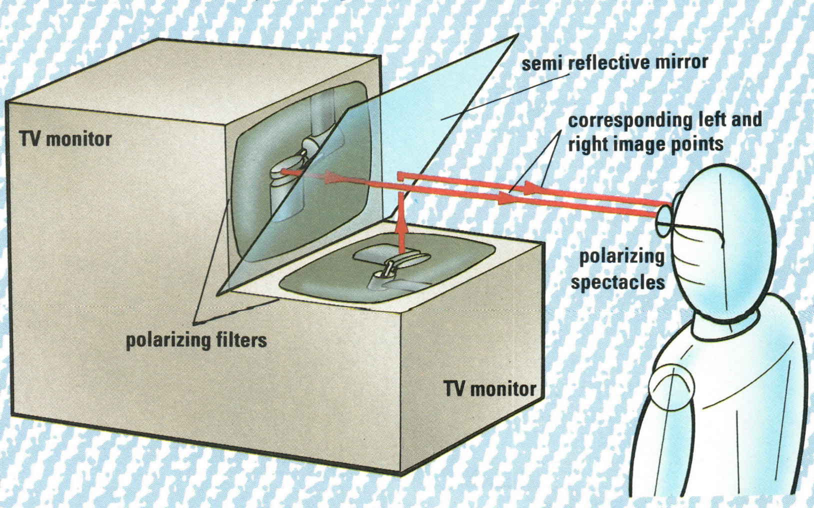
Once the computers are linked the whole system works automatically, without human intervention on the shop floor. And without expensive re-

3D TELEVISION

Conventional television, only showing two dimensions, is of little use when performing delicate tasks deep within a nuclear reactor.

To overcome this, scientists at the UK Atomic Energy Authority at Harwell have developed 3D television. Two cameras placed side-by-side two eyes' width apart are mounted on a remote inspection vehicle. The pictures are then relayed to two television monitors mounted at right angles to each other. One faces the operator directly, the other lies screen up in front of it. The screens are covered with polarizing filters, polarizing one image vertically, the other horizontally.

The two images are superimposed using a semi-reflective mirror placed at 45° between them. The operator views the combined image wearing special glasses with a vertical polarizing filter in one lens and a horizontal polarizing filter in the other – so the left eye only gets the image from the monitor connected to the left camera and the right eye only gets the image from the monitor connected to the right camera. The operator can then see and judge movements more accurately.



AEA Technology/Mark Franklin

tooling, stock piling and the over-production of unpopular lines, the factory can be run at maximum profits while keeping the cost of the products to the customer to a minimum.

Remote handling

In some industries tools must be handled remotely because the materials concerned are too dangerous to touch. Nowhere is this more necessary than in the nuclear industry.

Handling materials that are only mildly radioactive can be done in a glove box. This is a sealed box with a pair of long, heavy-duty gloves sealed into holes in a thick glass window. The operator can put his arms into the gloves from outside and handle radioactive material without it ever being exposed to the atmosphere.

Also in use is a method known as adjacent handling. Typically in this method the operator views his work through a shielding window and uses a pair of mechanically linked master-slave manipulators (MSMs).

Flexible Manufacturing Technology

***The control room** is an integral part of a computerized flexible manufacturing system. The main computer controls the scheduling of work through the system and supervises the machining centres.*

Massey-Ferguson

***Automatic guided vehicles** (AGVs) are used to transport components in warehouses and factories . They can be wire-guided by wires beneath the factory floor or laser-guided.*

Deeper within the sealed areas of a nuclear power station, however, robot arms are used. These are controlled by outside operators and are often suspended from gantries so they can move about the sealed area. However, their movement is limited and they cannot cope with unforeseen accidents or the huge range of problems that crop up when decommissioning a nuclear power station.

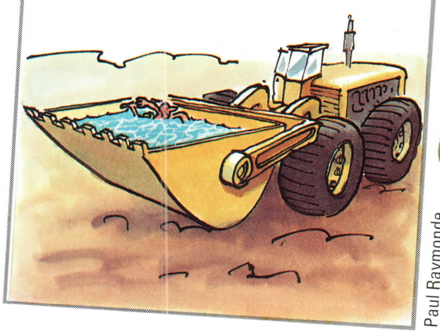
Walking machines and remote inspection vehicles have been developed, so that equipment in sealed areas can be checked and adjusted. Another use of the machines is their ability to scan and monitor hot spots on a surface and to successively decontaminate the area using an electrochemical method. They have been designed to climb stairs and negotiate difficult terrain even if the floor is cracked or damaged. These machines carry robot arms so that they can perform all sorts of functions deep within a nuclear power station. They may also be used in other areas dangerous to humans

The robot arm on these vehicles is remotely controlled by an operator outside the radioactive area, who uses 3D television (see box on page 117) for accurate scale and perspective. Thus industrial robotic developments are combined with the skill of a human operator. By using telerobots and remote inspection vehicles the element of human fatigue in causing error or accident is reduced and risk to personnel is minimized.

Just amazing!

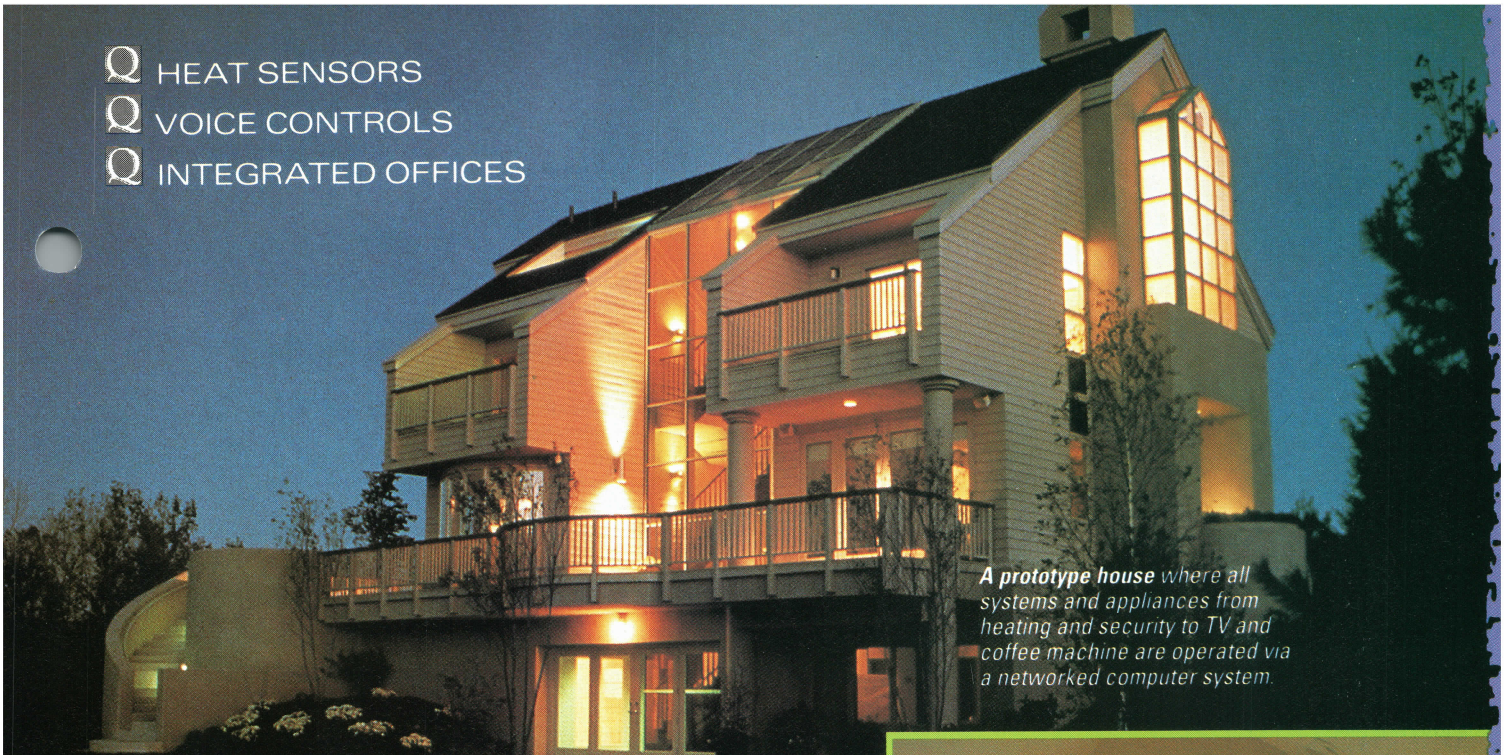
DIGGING DEEP

THE LARGEST EXCAVATOR IN THE WORLD, MADE IN HAMBACH, GERMANY, CAN CLEAR 200,000 SQM OF EARTH PER DAY - ENOUGH TO FILL 150 OLYMPIC SWIMMING POOLS.



Paul Raymonde

HEAT SENSORS
VOICE CONTROLS
INTEGRATED OFFICES

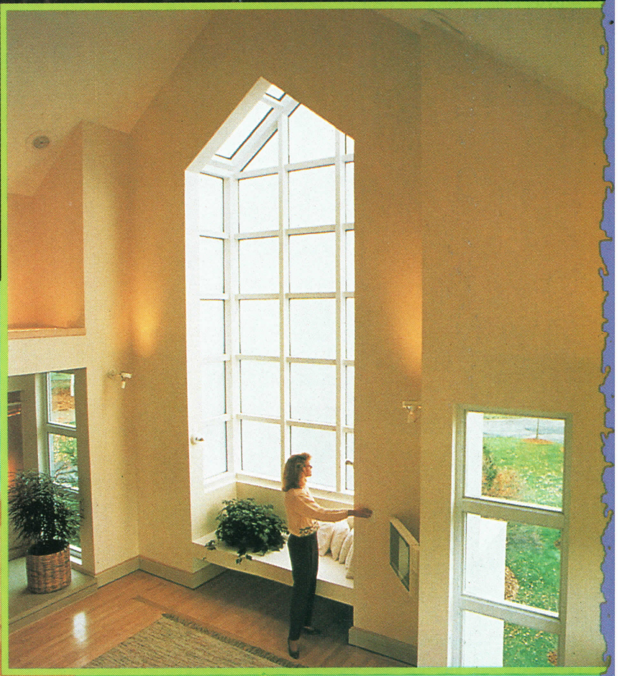


A prototype house where all systems and appliances from heating and security to TV and coffee machine are operated via a networked computer system.

BUILDINGS WITH BRAINS

FAR FROM SHELTERING us from the weather, new 'intelligent' buildings are evolving to take care of our every requirement at home and in the workplace.

Intelligent buildings are constructed around a computerized central control system that operates such amenities as lighting, heating, communications, entertainment and security. Computers control and co-ordinate all of these functions at the touch of a button on either a fixed console or a remote control device.



***A liquid-crystal window** is white in its normal state – allowing light in while providing privacy. At the touch of a button, a current runs through the window to realign the crystals and turn the window transparent. Commands for such functions are sent to the central computer via touch-control screens (left).*

Jerrican

Energy monitor

A central computer can even be programmed to act automatically so that, for example, as it gets dark outside, the lighting level gradually increases inside and when people leave a room the computer turns off the lights – making light switches obsolete and saving energy.

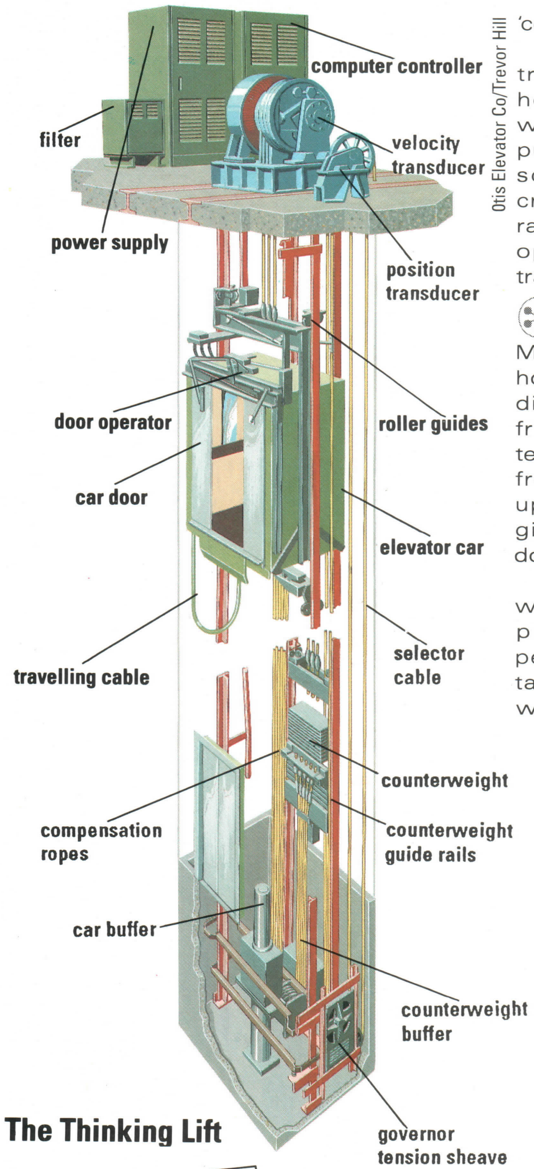
Heating can be controlled similarly. Sensors at strategic points will detect when temperatures vary from pre-set values and adjust the heating system accordingly for individual rooms. For greater efficiency the system can be programmed to switch room heaters off when a room is empty.

The new houses will be cost effective in other ways too. If the washing machine can 'communicate' with the electricity meter, it will wait until the electricity supply is at its cheapest to wash your clothes.

The central computer could even be activated by voice commands. There are already prototype buildings in the United States, where pre-set programmes can be operated by vocal instructions. For example, saying aloud 'privacy mode' will prompt the computer to lower window blinds and lighting levels, the words 'evening party' will bring on spot lights and start music playing on the stereo.

Burglar alarm

The integrated building concept will first become accepted through home entertainment equipment. Already many people are familiar with programming video recorders to



The Thinking Lift

Otis Elevator Co/Trevor Hill

'communicate' with their televisions.

Communication between all electric systems and appliances in the home will mean that, for example, while watching television, the computer will flash messages on to the screen to tell you that your microwave dinner is ready; or that it is raining and the upstairs windows are open; or that security cameras are tracking an intruder in the garden.

Helping the disabled

Many functions of an integrated home will be especially useful for the disabled. For example, a picture of friends arriving will be relayed on the television screen from cameras at the front door. The host, without getting up, will be able to press a button or give a vocal command to open the door and let in the guests.

In the office an integrated system will, for example, flash important telephone or fax messages on to a person's VDU screen while they are taking another call and inform them when a client has arrived in reception.

***Advanced gearless elevator systems** in high-rise offices and hotels can now 'anticipate' passenger demands. Their computer memories monitor and 'learn' traffic patterns. For example, on Monday morning the system will check data from ten previous Mondays. It will notice that the rush hour on Mondays is later than on other days and will assign cars to certain floors at times when they should be most needed. Communication between cars also ensures they do not all respond to the same calls.*

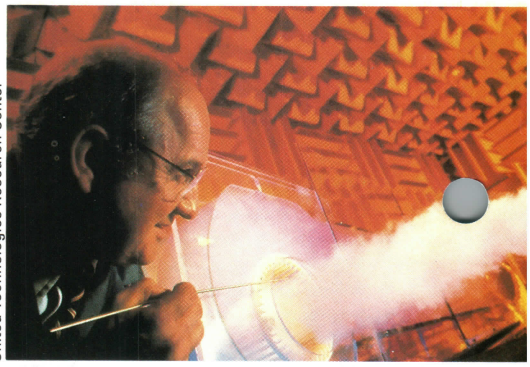
Just amazing!

GOING UP

OTIS – THE WORLD'S LARGEST ELEVATOR COMPANY – CARRIES OVER 64 MILLION PEOPLE DAILY IN ITS ELEVATORS – MORE THAN THE ENTIRE POPULATION OF ITALY.

Paul Raymonde

***An engineer** substitutes smoke for air to study the complex flow through an air-conditioner. All such building systems will be refined to provide maximum efficiency in the future.*



United Technologies Research Center

INTO THE FUTURE

STAFF BENEFITS

▲ *Built-in office computer systems will control temperature and humidity and will boost negative ions in the air supply to promote a feeling of well-being in staff.*

▲ *Even on the dullest days artificial light sources will imitate the natural sunlight of a beautiful day. Inspiring background music will be available on request.*

▲ *In the event of fire, recorded voices will calmly direct workers to safety while sprinklers are activated and fire services alerted automatically.*

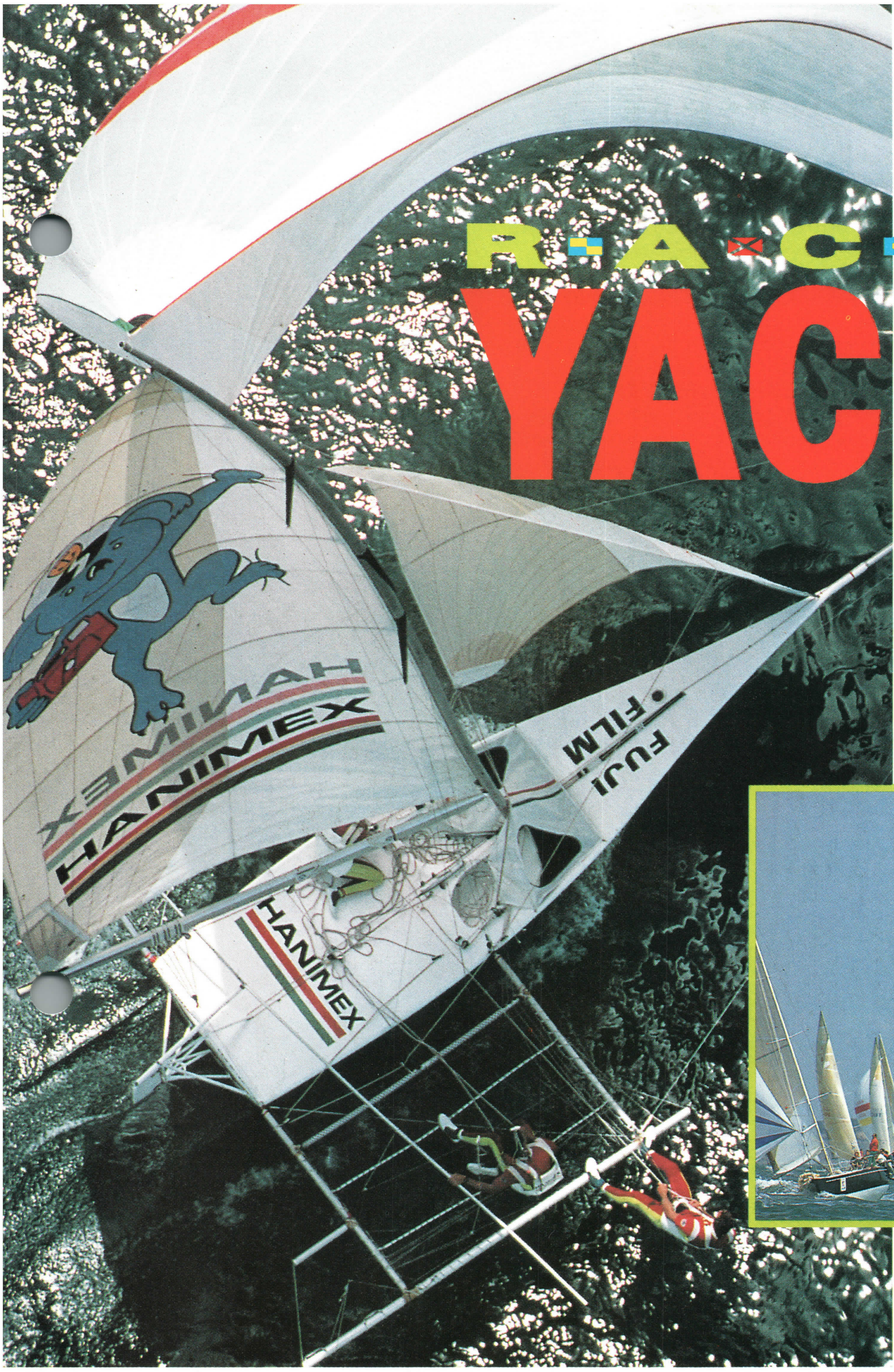
Joe Lawrence

GAMES THEORY

DRAG REDUCTION

MULTIHULLS

R·A·C·I·N·G YACHTS



Yachts compete *within a framework of regulations and sometimes with handicaps. This 5.5-metre skiff was photographed at the Grand Prix off Perth, Western Australia, in 1987.*

Action Plus

The mainsail *(single-coloured sails below) provides much of a boat's power and balances its helm. In use for the duration of a race, the mainsail must be very tough.*

Leo Mason/Split Second

WHEN *STARS AND STRIPES* swept across the finishing line in 1987 to win the prestigious America's Cup, a new era in the development of hi-tech racing yachts began. For the first time, computers had been used extensively to calculate the ideal shape for a competition yacht's sails, hull, and keel.

Four years earlier, the United States had been stunned by the loss of the America's Cup to *Australia II* in the final held off Newport, Rhode Island, USA. The success of *Australia II* was due largely to a revolutionary new keel design. Instead of the simple upright keel of an ordinary yacht, the one fitted to *Australia II* had two winglets (small wings) at its base. This was kept a closely guarded secret until the race was over.

A yacht's keel has two main purposes. First, it helps to turn sideways wind pressure on the sails into forward movement of the boat. Second, it can be weighted so that it acts as a ballast to help prevent the boat from tipping over when the wind blows sideways on the sails. On a 12-metre vessel used in the America's Cup, lead ballast accounts for 70 to 80 per cent of the boat's total weight. A keel with winglets also serves as a hydrofoil, providing lift or pulling the craft down.

Winglets

Using a set of specially written programmes running on a minicomputer, the designers of *Stars and Stripes* made improvements to the Australian winged keel idea. These included giving the keel more taper from front to back, thicker keel-tip sections to make the keel more streamlined, and wider winglets.

The computer also helped to test various sizes and shapes of sails. Traditionally, sail plans were drawn by hand and the final, full-scale version laid out in a large open loft. For *Stars and Stripes* the sails were designed using a computer.

Weather forecasts

At each stage, the performance of the keel, hull, and sails was modelled by the computer under a variety of race conditions. The designers took account of the likely state of the sea and weather off Perth, Australia, where the competition would be held. They also found out as much as possible about the opposition's boats. A program using mathematics known as games theory then predicted what was the most likely design to win over a variety of wind strengths and sea conditions.

In the future, computers will play an even greater role in the design and testing of advanced sailing ships.

Since this will avoid the expense of building many real prototypes, designers will have much more freedom to experiment with various new shapes and configurations.

Riblets

Friction between hull and water is one of the main factors that slows down a racing yacht. Many coatings have been developed to reduce this drag, but few have proved to be any better than a perfectly clean, polished, painted surface. One that is superior, however, is an experimental thin, self-adhesive, vinyl film developed by the 3M Company for aircraft.

The 3M material contains microscopic parallel grooves called riblets. These smooth the flow of passing air or water by channelling the fluid along streamlines. First used on the hull of *Stars and Stripes*, this new coating is thought to have reduced friction by up to 4 per cent.

There are about 950 classes of racing yachts, from ocean-going giants costing millions of pounds to the Optimist class of dinghy, popular with children. Some of the fastest classes of sailing boats are multihulls.

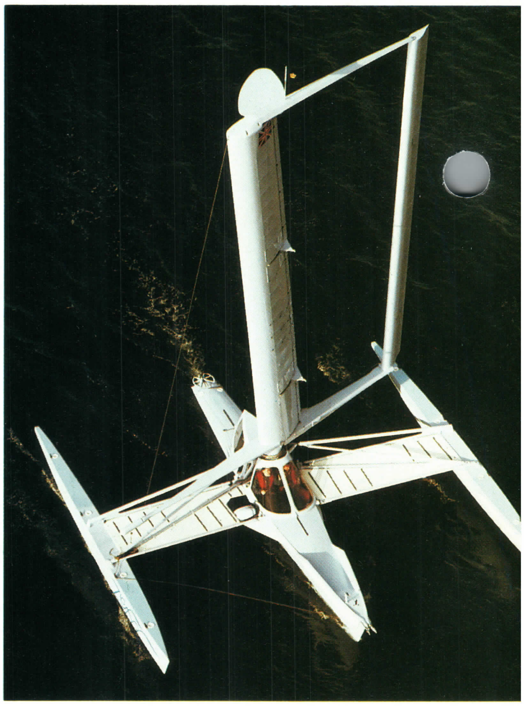
A catamaran has two hulls, while a trimaran has a central hull with small hulls on either side. The main advantage of a multi-hull is that it rides higher than a monohull, enabling it to skim over the water.

Boats with a single main hull attached to a small float are called proas. The world speed record for a sailing boat is held by *Crossbow II*, a 22-metre proa that averaged 66.8 km/h over a 500-metre course in Portland Harbour, Dorset, UK in 1980.

Wingsails

One of the latest high-performance yachts is a trimaran that uses a set of rigid, vertical wings instead of conventional sails. These so-called 'wingsails' have flaps, air-directing slats, and motorized actuators to move them, as on an aircraft wing.

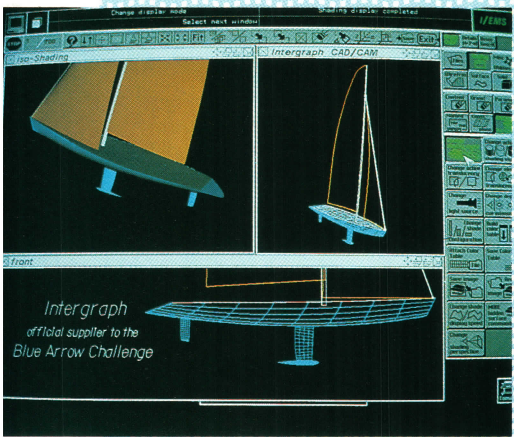
Mounted on the hull by a large ball-joint, each can be controlled manually or by a microcomputer fed with data on the direction and speed of the boat by sensors placed around the hull.



Walker Wingsail Systems plc

***Rigid sails**, as on this racing trimaran, may be the technology of the future. The craft is operable by one person with no sail rigging. A computer translates pilot commands into flap and tailfin angles according to wind, boat speed and direction.*

DESIGNING A RACE-WINNING YACHT



Intergraph/N Rains/Pickthall Picture Library

Today, computers are used to design and test many aspects of racing yachts. Understanding the stresses of flying sails, for example, helps to design sails that hold their racing shape better.

In recent years the materials used to build racing yachts have changed also. Aluminium and wood hulls are being replaced by laboratory produced fibre reinforced plastics (FRPs). FRPs, or advanced composites, are combinations of resins and fibre reinforcements. Fibres – of, for example, carbon, aramid, polymer or combinations of these – provide the base material and resins hold the fibres in place, protect them from damage and help to spread force between fibres. The end product is lighter, stiffer and stronger than its traditional counterparts and is used in the construction of aircraft, road vehicles and rescue boats as well as racing yachts.

SP Systems Ltd

An FRP half-hull (above) is coated with resin. The resin becomes liquid when heated to 75° C and must be pressed into the hull and worked smooth before it cools and sets.

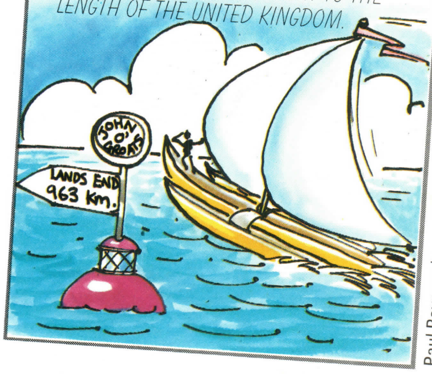
N Rains/Pickthall Picture Library

***Wing flap settings** on the 32.5-metre-tall rigid mainsail of the Stars and Stripes are finely tuned. Wingsails – developed from aeroplane wings – are ideal for racing yachts because they work more efficiently the faster the yachts travel.*

Just amazing!

WIND POWER

IN 1987, DURING A TRANSATLANTIC CROSSING, A TRIMARAN, AVERAGING A SPEED OF 40.1 KM/H, SAILED 963 KM IN ONE DAY – EQUIVALENT TO THE LENGTH OF THE UNITED KINGDOM.



Paul Raymonde